LIFE HISTORY OF THE FISHFLY, *NIGRONIA FASCIATUS* (MEGALOPTERA: CORYDALIDAE)

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The objective of this study was to describe certain aspects of the life history of the fishfly, *Nigronia fasciatus* (Walker), in a small, woodland stream in Cabell County, West Virginia. Some investigators, including Tarter and Watkins (1974), Evans (1972), Neunzig (1966) and Cuyler (1965), have reported taxonomical and distributional information on this fishfly. The egg masses, eggs, and first-instar larvae of *N. fasciatus* were described by Baker and Neunzig (1968), and the mature larva by Cuyler (1965) and Neunzig (1966).

The genus *Nigronia* Banks 1908 includes two recognized species in North America, *N. fasciatus* (Walker) and *N. serricornis* (Say). *N. fasciatus* was originally described by Walker (1853) as *Chauliodes fasciatus*. It has been collected in New York, Pennsylvania, Ohio, Glen Echo, D. C., Maryland, Illinois, Missouri, Arkansas, and Mexico (Davis, 1903). In West Virginia, Tarter and Watkins (1974) reported *N. fasciatus* from eight major drainages in 15 counties. The larvae are most often found under rocks and logs in small, woodland streams.

Materials and Methods

Hisey Fork, a small, woodland stream in Cabell County, West Virginia, is the study area. The stream flows northeast for 7.4 km and empties into Fourpole Creek near Huntington, West Virginia. The average gradient is 45 m/km. The stream is about 1 m wide throughout its length, and the water depth is about 0.1 m. The substrate consists of sand, coarse rubble and large boulders. The riparian woodland is composed of beech *Fagus grandifolia* Ehrh., yellow poplar *Liridendron tulipifera* L., oak *Quercus* spp., and hickory *Carya* spp.

This study was initiated in September 1972 and continued until August 1973. To study the life history of *N. fasciatus,* the year was

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divided into four seasons; fall (Sept.-Nov.), winter (Dec.-Feb.), spring (Mar.-May), and summer (June-Aug.). Usually a single collection was made during the middle month of each season. Larval fishflies were collected from under rocks (8-50 cm in diam) and in logs throughout Hisey Fork by handpicking with forceps. Generally, the larvae occurred about 1 per 20-30 meters of stream length. They were placed in boiling water to prevent shrinkage and stored in 70 per cent ethanol.

Size-frequency distributions of head widths, arranged in 0.2 mm groups, were employed each season to determine the size classes of *N. fasciatus* larvae. Also, 211 larval head widths, measured with a dial vernier caliper (nearest 0.1 mm), were used as an index of growth.

Data regarding larval food habits were determined by foregut analysis. The foreguts were excised and the contents sorted into various taxonomic categories under a dissecting microscope. The number of specimens in each taxon was counted and recorded for each foregut. The following calculations were made seasonally: (1) the percentage of foreguts in which a particular taxon occurred (percentage frequency of occurrence) and (2) the average number of specimens in all foreguts containing that particular taxon.

Fecundity in the adult fishfly *N. fasciatus* was determined by direct counts of ovarian eggs. Both ovaries of 10 adults were removed and a total of 6802 eggs were counted. The regression of fecundity on total length was calculated and a coefficient of correlation determined.

Water temperature was measured with a thermometer placed near the bottom. Determinations of total alkalinity, total hardness as $CaCO_3$ and pH were carried out in the laboratory with a Hach chemical kit, Model DR-EL. Dissolved oxygen concentration was measured in the field with a Hach chemical kit, Model AL-36-WR.

Results and Discussion

Stream Environment. — During the study period, water temperature ranged from 5.6 to 18.3 C, winter and summer, respectively. The average pH value was 7.7 (range, 7.0-8.0). The waters usually were supersaturated with dissolved oxygen which ranged from 9 to 13 mg/l ($\bar{x}$ = 11 mg/l). Total alkalinity concentrations ranged from 45 to 85 mg/l, winter and summer, respectively ($\bar{x}$ = 68 mg/l). The average total hardness concentration was 163 mg/l; the range was 120 (spring) to 210 (summer) mg/l.

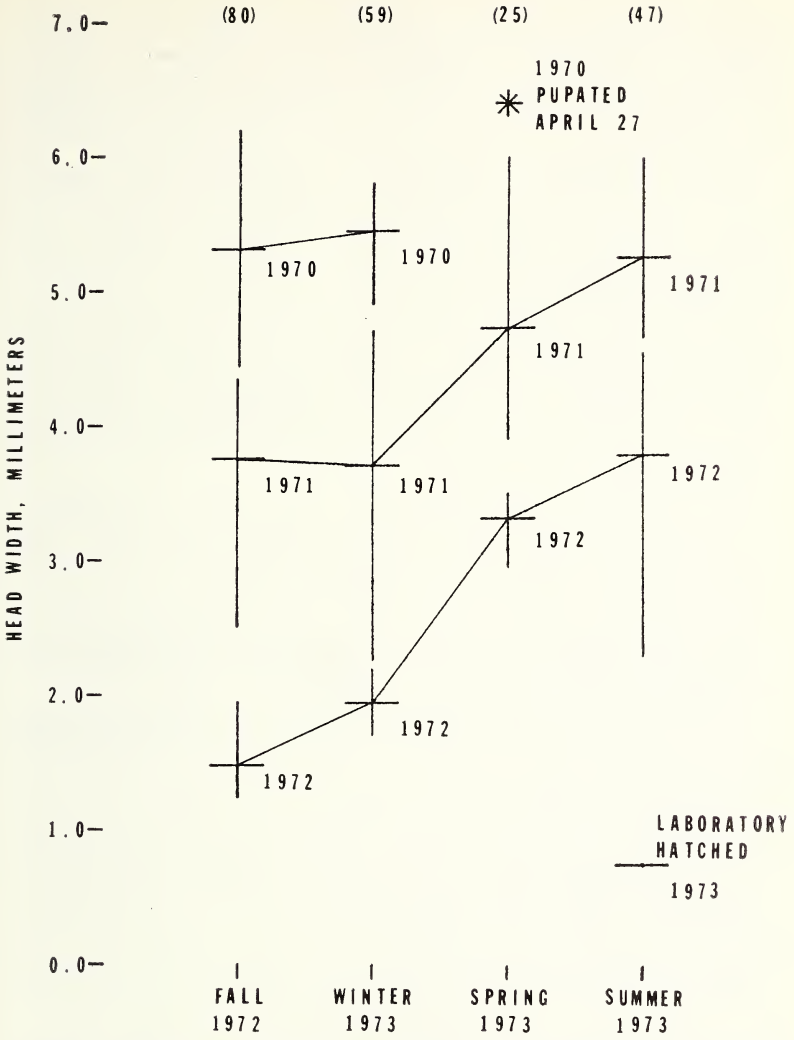

Figure 1. Seasonal size-frequencies of *N. fasciatus* larvae from Hisey Fork, Cabell Co., W. Va. Number of larvae is given in parentheses, and size classes are marked with year of hatching.

Larval Food Habits. — The following food categories were identified in the foreguts of larval fishflies from Hisey Fork: Isopoda, Diptera, Ephemeroptera, Megaloptera, and Trichoptera. Of the 181 foreguts examined, 170 (93.9%) contained food and 11 (6.1%) were empty. The highest percentage of empty foreguts (8.9%) occurred in fall.

Of the identifiable food materials, the isopod *Asellus militaris* (Hay) ranked first in percentage frequency of occurrence in all seasons. It ranged from 22.9 per cent in summer to 56.0 per cent in spring. The largest number (27) and the highest average (1.2) of isopods occurred in fall.

Larvae of the caddisfly *Cheumatopsyche* sp. ranked second to isopods in percentage frequency of occurrence in summer (14.3), fall (19.7) and winter (18.0). Pupation and emergence could be responsible for their lowest frequency (8.0%) in spring. In fall, the highest average (1.1) and greatest number (15) of larval caddisflies occurred in the diet of the fishfly.

A limited number of mayfly naiads, *Ephemerella coxalis* McDunnough, entered the diet in the spring and summer. The naiads ranked second (20.0%) to isopods in percentage frequency of occurrence in spring.

Chironomid larvae were consumed in winter, where they occurred with a frequency of 10.3 per cent. They ranked behind isopods and caddisflies as a food source for larval fishflies.

Some cannibalism was found in all seasons. It reached the highest frequency of occurrence (11.4%) in summer, where four *N. fasciatus* larvae were consumed.

Digested and unidentified materials comprised a high percentage frequency of occurrence in fall (55.0), winter (46.1) and summer (51.4). In spring, they were found in 24 per cent of the foreguts.

Minshall (1967) reported that larvae of *N. fasciatus* from Morgan's Creek, a woodland springbrook in Meade County, Kentucky, consumed *Gammarus, Asellus, Ectopria* and unidentified amorphous materials. The guts of most larvae were partially full, and the consumed material was of indeterminate nature.

Larval Development. — The larval population of *N. fasciatus* consisted of three size classes (Fig. 1). In the youngest size class (1973, year of hatching), laboratory hatched larvae in June measured 0.75 mm in head width (Fig. 2 and Table 1). The smallest larva in the stream measured 1.3 mm in head width and was collected in fall (29 November 1972). The method of collection precluded getting large numbers of the youngest size class from the

Table 1. Seasonal head widths (mm) of larval size classes of *N. fasciatus,* Hisey Fork, Cabell Co., W. Va.

Size Classes (Year of Hatching)	Fall	Winter	Spring	Summer
1970	$\bar{x} = 5.3$ (4.5-6.2) N = 41	$\bar{x} = 5.5$ (4.9-5.8) N = 27	PUPATED	———
1971	$\bar{x} = 3.8$ (2.5-4.4) N = 35	$\bar{x} = 3.7$ (2.5-4.7) N = 30	$\bar{x} = 4.7$ (3.9-6.0) N = 20	$\bar{x} = 5.3$ (4.7-6.0) N = 22
1972	$\bar{x} = 1.5$ (1.3-2.0) N = 4	$\bar{x} = 2.0$ (1.7-2.2) N = 2	$\bar{x} = 3.3$ (3.0-3.5) N = 5	$\bar{x} = 3.8$ (2.3-4.6) N = 15
1973	———	———	———	$\bar{x} = 0.8$ (0.8) N = 10

stream. The mean head width of larvae at the end of the first year of development (1972) was 3.8 mm (Table 1 and Fig. 2). After the 2nd year of development (1971), the mean head width was 5.3 mm (Table 1 and Fig. 2). At the end of the 3rd year (1970), just prior to pupation, the mean head width was 5.5 mm (Table 1 and Fig. 2).

Larval head width demonstrated seasonal changes in growth (Fig. 2). The greatest growth rate (69.7%) of the larval population, occurred from winter to spring in the 1972 size classes. This development coincided with the greatest seasonal changes in water temperature, 5.6 C and 16.0 C, winter and spring, respectively.

Pupal Stage. — One pupa was collected in the spring (April 27). It was found under a flat rock (ca 45 cm in diam) in an earthen cell 30 cm from the stream. Based on field observations of the first adult, pupation lasted approximately 21 days.

Neunzig (1966) reported that *N. fasciatus,* in Nature Trail Creek, North Carolina, started pupation around May 5 and reached a peak the following week. The pupae were located under moss in earthen cells about 6-12 inches from the creek. Minshall (1968) noted that *N. fasciatus* from Morgan's Creek, Kentucky, pupated in the early spring (April).

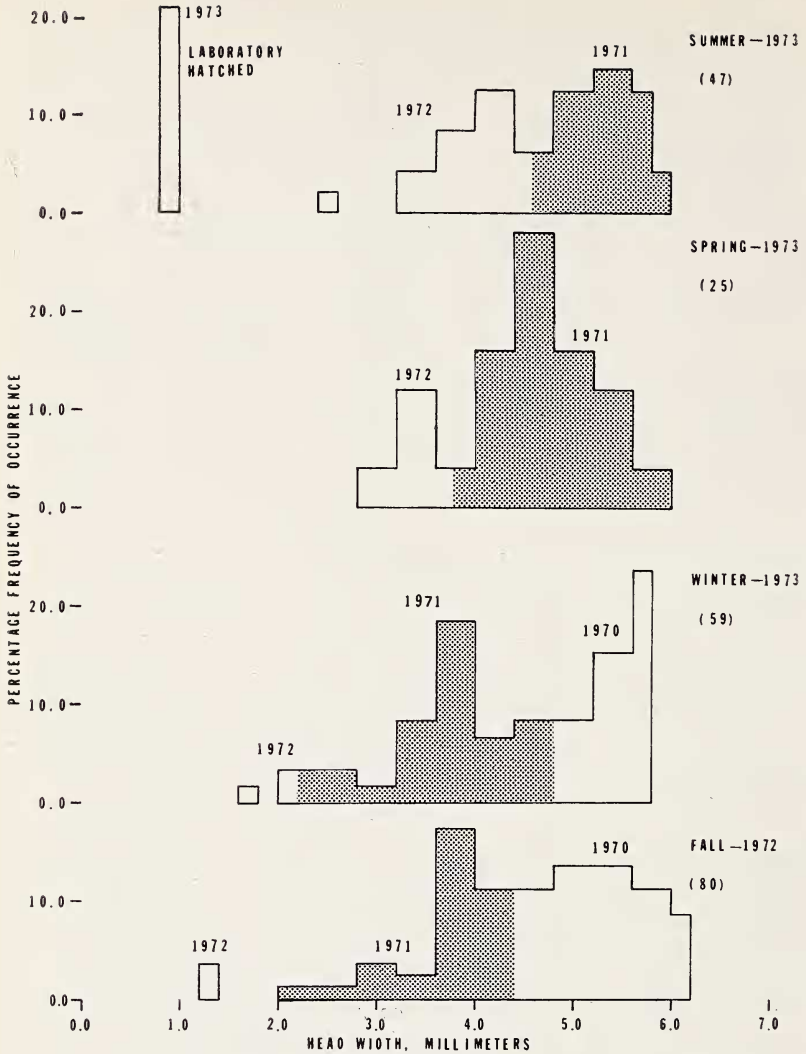

Figure 2. Seasonal variation of the head width in *N. fasciatus* larvae in Hisey Fork, Cabell Co., W. Va. Vertical lines = ranges, horizontal lines = means.

Adult Stage. — The first adult fishfly was collected near the stream on May 16. In one hour 13, 8 and 3 adults were observed on May 20, 22, and 25, respectively. On different occasions, several wings of adult fishflies were found scattered along the stream bank. Apparently, birds or other predators had fed upon the adults. No wings or fishflies were found after May 25. The approximate flying season for *N. fasciatus* was 10 days.

Oviposition was observed in the field on May 20 and 22. Females oviposited their entire egg mass on the underside of leaves 4-6 m above the stream between 1300 and 1600 hours. Several leaves with egg masses were brought to the laboratory and suspended over water. Hatching occurred in 14 days and first-instar larvae (1.5-2.0 mm, body length) fell into the water and crawled underneath rocks.

There was high correlation ($r = 0.95$) between the numbers of eggs produced and the total length of female fishflies. The following equation was calculated to express this relationship.

$$Y = -2800.0 + 93.9X$$

where Y = the number of eggs, and
X = total length, mm

Ovarian egg counts of 10 females showed a range from 275 to 1134 eggs per female ($\bar{x} = 680$).

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